DEPARTMENT OF THE NAVY
NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER
WASHINGTON, D. C. 20007

THE APERTURE CARD AS AN ADJUNCT TO A COMPUTERIZED INFORMATION SYSTEM

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ABSTRACT

This report focuses on the use of the aperture card as an adjunct to a computerized information system. System configuration, economics, environment, and functionality are the salient points considered.

ADMINISTRATIVE INFORMATION

This work was sponsored by the Office of Naval Research (Code 400DE) and funded under Subproject RF 009 88 01. The material contained in this report was presented by the author on 28 May 1968 at a Symposium on Mechanizing the Information Process. The symposium was held in Washington, D. C. under the sponsorship of the National Archives and Records Service, General Services Administration.

INTRODUCTION

Storage media for information have steadily evolved. Man, through his ingenuity and creativity, has enhanced manifold his capacity for recording and preserving information for his later use and for posterity. One of these media for capturing data is the aperture card. Figure 1 shows its appearance and structure.

The aperture card represents a combination of two older techniques for recording information—microfilm and EAM card. Interestingly, both microfilm and the EAM card have been around for some time, although it was only relatively recently that they were combined to form the aperture card. Jackson indicates that experiments in microphotography can be traced back to 1839.* The history of punched cards even predates microfilm. Control cards, the probable ancestor of the punched card, were first used for the Jacquard loom which appeared in 1780.* The punched card as we know it today was introduced about 1880 by Dr. Herman Hollerith for use in the United States Census.* So in a real sense, the aperture card is new, but yet old.

The aperture card subsystem outlined here is an adjunct to the Navy Automated Research and Development Information System, generally referred to by the acronym NARDIS. Therefore, in order to describe how the aperture card fits into the NARDIS environment, it is necessary that NARDIS itself be understood in terms of what it is and how it works.

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*See the Bibliography at the end of this report.

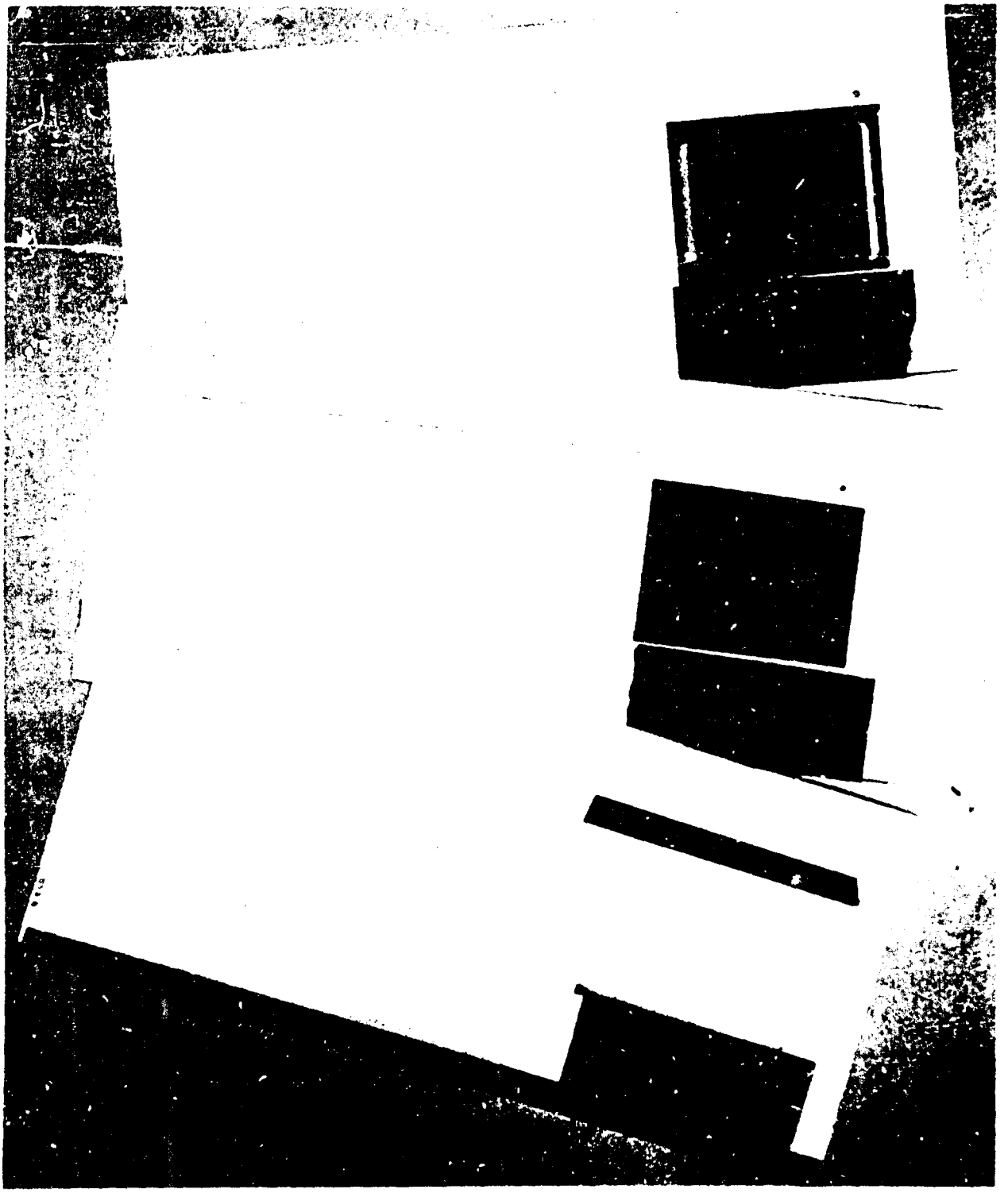

Figure 1 – Sample Aperture Card

Indexing represents the means of ensuring subsequent subject-matter retrieval. It involves reading each document for intellectual concepts, selecting controlled vocabulary descriptors to express these concepts, and linking the descriptors as a means for expressing a concept that can be retrieved later. Such a method considerably enhances the relevance of the retrieval results and reduces the noise ratio. The indexing methodology of NARDIS is based on the Engineers Joint Council Coordinate Indexing System minus the use of roles.

System flexibility is inherent in the design of the file maintenance, search, and retrieval functions. The file maintenance element provides a capability for deletions, insertions, replacement by document, and replacement by data field (smallest unit of information in the file). The search and retrieval functions provide for data retrieval as well as subject-matter retrieval. Moreover, the system provides for updating, retrieval, and report generation in the batch mode. Figure 2 graphically summarizes the foregoing. With this NARDIS orientation, we may continue the principal subject of discussion—the aperture card and its role in NARDIS.

One of the requirements stipulated for the implementation of NARDIS was the establishment of a suitable microfilm subsystem as a backup to the NARDIS computerized data base. In selecting the microfilm equipment, it was necessary to keep in mind that NARDIS is a system based on, at most, a two-page report. The system is also subject to continuous updating; therefore the following attributes and features were needed in any equipment selected:

1. Simple processing and operating techniques
2. Selective updating
3. High quality microphotographic capability
4. Low maintenance requirement
5. Rapid retrieval
6. Reasonable "hard copy" capability
7. Minimum storage requirements
8. Low overall cost

After much consideration and evaluation of a wide spectrum of available microfilm equipment, it was decided that the aperture concept was the most feasible approach. As the basic element in the microfilm subsystem, the aperture provided simplicity in respect to operation, facility, and utility in updating and reduction in storage requirement. Accordingly, the aperture card became the embodiment of the NARDIS microfilm subsystem.

APERTURE CARD SUBSYSTEM

The aperture card subsystem is configured as follows:

1. Processor – Camera (one)
2. Dry Silver Printer (two)

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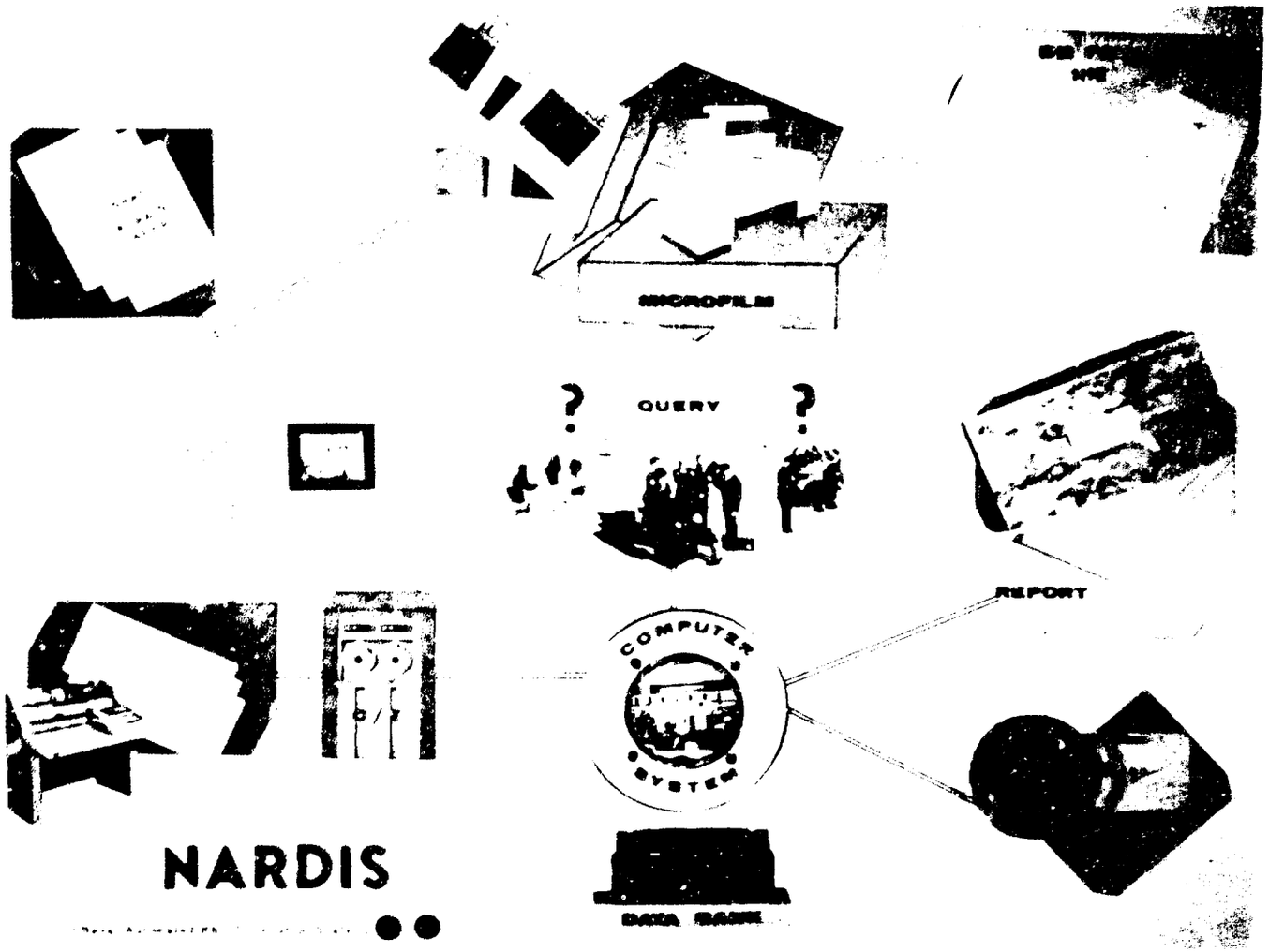

Figure 2 – NARDIS Overview

3. Aperture Card Copier (one)
4. Viewers
5. File Storage

As an appendage to NARDIS the aperture card subsystem is generally subdivided into file update and retrieval processing cycles. These two subdivisions within the subsystem are explored as an extension of the total system.

Updating Cycle

The underlying philosophy of the updating cycle of the subsystem is very simple; basically it involves the acceptance of computer-generated resumes as the single input medium. Since the computer-generated resume approximates the regular size computer printout (10 5/8 × 14 inch), a 24 : 1 reduction is necessary to fit one page of the report into a quadrant on the aperture card. After a document has been microfilmed, a diazo copy* is made of the original microfilm copy. Both copies are appropriately identified as to the accession and security classification of the report captured on the aperture cards.

Simplicity is characteristic of the update method employed for the aperture card subsystem, that is to say, the file is conventionally maintained linearly and sequentially according to accessions. No file inversion is utilized. To further facilitate updating, the file is segmented into cells of 100 aperture cards (see Figure 3). This reduces access and retrieval time significantly.

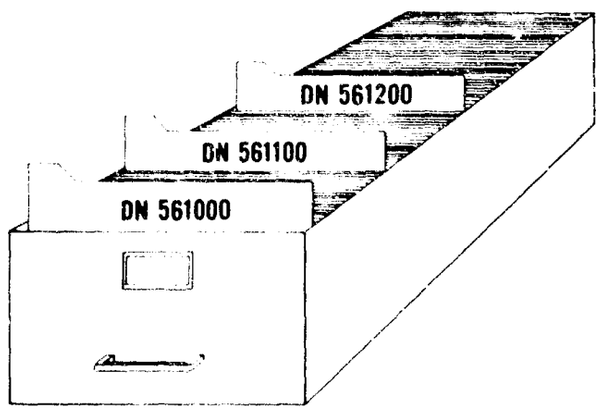

Figure 3 – Aperture Card File

*A slow print film or paper sensitized by means of azo dyes which, subsequent to exposure of light strong in the blue to ultraviolet spectrum and development by ammonia vapor or alkaline solution, forms an image. See the Bibliography for a monograph by Anedon.

Two vital functions associated with the updating cycle remain after the report has been microfilmed, namely either the insertion of a new report or the replacement of an existing report in the aperture card file.

To summarize, the update cycle requires the following steps to be performed:

1. Microfilm computer-generated resumés.
2. Make diazo duplicate of the original aperture card.
3. Affix accessions to both the original and copy.
4. Locate and remove the "old" aperture card.
5. Insert the new or updated aperture card in the file (see Figure 4).

If the aperture card represents a new resumé or report, Step 4 in the processing cycle is not performed. These procedures highlight the inherent simplicity of the subsystem and further underscore the independent nature of each report in the aperture card file. Had the file been reposited or captured on roll film, the updating process would have necessitated splicing the film or remicrofilming the entire contents of the roll of film. Updating is not a problem with an aperture card subsystem for a change of one report involves only that report.

Retrieval Cycle

At the outset, the aperture card subsystem was described as an adjunct to NARDIS. During the discussion of the retrieval cycle (see Figure 5), it will be shown that the subsystem as an entity does not involve any mechanized processing or manipulation of the aperture card file from the standpoint of retrieval. The aperture card file is accessed only after the computer data base or other retrieval sources have been massaged.

To elaborate, this means that the actual retrieval to satisfy given criteria is done by engaging the computer or using computer-generated subject and category indexes. For example, if a query is processed on the computer, an accession list of all the reports satisfying the constraints of the query is provided. Since the accession list (see Figure 6) is in sequence by accession number, it coincides with the sequence of the aperture card file and facilitates retrieval of pertinent reports. This represents one mode of determining which reports are to be retrieved from the aperture card file.

Even quicker than a computer batch mode search is a "hand search" based on computer-generated subject indexes of the NARDIS data base. Of course, this is true only for a simple query and not a complex one. Several indexes are presently used in conjunction with NARDIS retrieval operations. These include:

1. The Keyword Inverted Index
2. The Permuted Title Index
3. The NARDIS Inverted Subject Matter Index

These indexes enable the query indexer/coordinator to ascertain instantaneously those reports that satisfy a given query. This, in turn, gives the indexer a direct entry point to

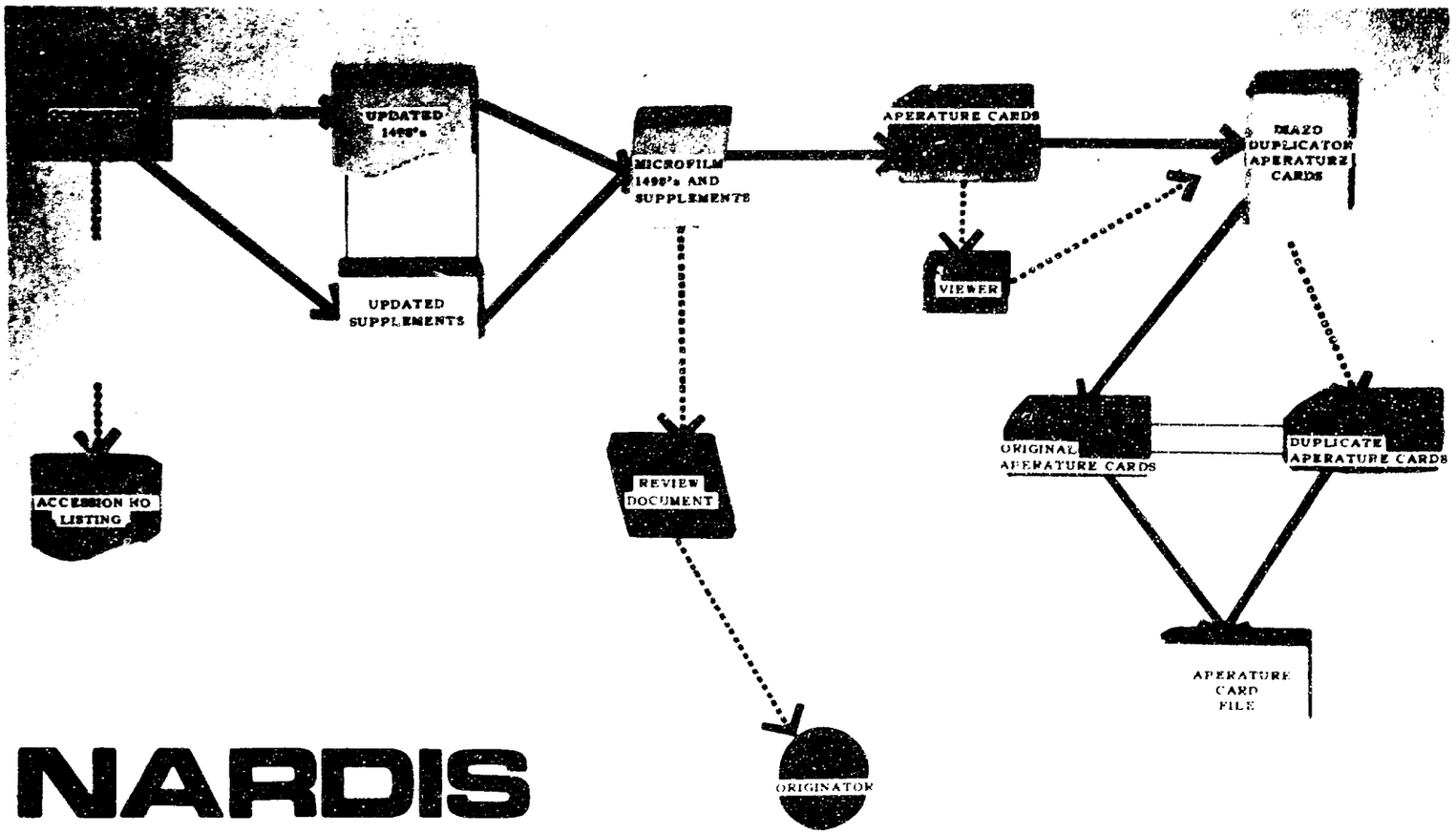

Figure 4 – Aperture Card Subsystem Updating Cycle

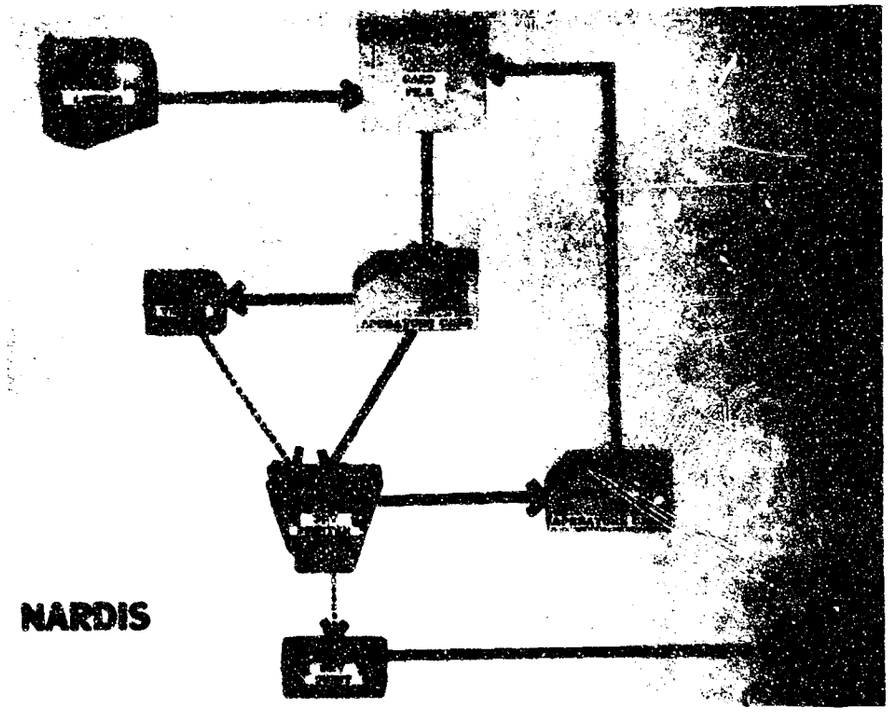

Figure 5 – Aperture Card Subsystem Retrieval Cycle

the aperture card subsystem. For instance, suppose we are interested in getting hard copies of all reports that discuss MECHANICS. What is important here is (1) determining if ther are any reports in the system that address themselves to the subject of MECHANICS and (2) determining the identity of these reports. Note in Figure 7 that there are four reports concerned with MECHANICS. The word MECHANICS was embedded in the titles of these reports. Furthermore, the identities of these reports are provided as the accessions which appear to the far left of the title. In this case, Accessions 530552, 723426, 72311, and 516106 are the entry points to the aperture card file. It is now a simple matter to obtain "hard copies" of the reports.

Similarly, the NARDIS Inverted Subject Matter Index and the Keyword Index can be used to determine entry points to the subsystem. At this point, it is necessary to differentiate between the subject matter and the key word indexes. The Subject Matter Inverted Index represents the indexing terms used to describe the intellectual concepts embodied in the reports that comprise the data base. The terms are scrutinized by the indexer and selected by him from the NARDIS Thesaurus. In contrast, the key words are terms supplied usually by the originator of the report. Key words may or may not appear in the Thesaurus.

NARDIS LOGISTICS RETRIEVAL-QUESTIONS ANSWERED BY RUN 16

QUERY NO.	PART NO.	AGENCY ACCESSION NUMBER	RPT. CLASS	WRK. CLASS	
380	1	DN890006	S	S	D
380	1	DN890007	C	S	D
380	1	DN890008	C	C	D
380	1	DN890009	S	S	D
380	1	DN890010	C	C	D
380	1	DN890011	C	C	D
380	1	DN890012	C	C	D
380	1	DN890013	U	C	D
380	1	DN890014	C	C	D
380	1	DN890015	C	S	D
380	1	DN890016	C	C	D
380	1	DN890017	C	C	D
380	1	DN890018	C	C	D
380	1	DN890019	U	C	D

Figure 6 – Accession Listing

NARDIS PERMUTED TITLE INDEX

JUN 2 1967
NSRDC 1880

C L	ACCN NO (DN)	TASK AREA	L V L	LAB NUMBER	CONTRACT NUMBER	TITLE CLAS	
C	530552	WF0090802	A	1033216IPAI		(U)	MECHANICS * CONTINUUM
U	723426	[illegible]0090101	A	NR062387020S	P060113	(U)	MECHANICS * NEO-CLASSICAL
U	723111	RR0090101	A	NR062388C	N0001466C0064A03	(U)	MECHANICS * STATISTICAL
U	516106	SF0200302	A	6062	NOBS90269	(U)	MECHANICS * THEORETICAL

Figure 7 – Permuted Title Index

With this distinction clearly in mind, let us suppose that we desire a "hard copy" of every report that deals with ANTIGENS AND ANTIBODIES. Inverted Subject Matter Index (see Figure 8) indicates that there are 89 reports in this category. And so, with a list of the accessions, the reports become retrievable from the aperture card file and corresponding "hard copies" can be made available.

As a final illustration of the retrieval aspects associated with the aperture card subsystem, consider the hypothetical case where there is a request for all reports that discuss the subjects of both DENTAL OFFICERS and DENTAL TECHNICIANS. These two terms must appear in the same reports. A careful check of the index reveals that the coincidence of these two terms appears in a report with the accession DN 541304. Figure 9 illustrates

the case in point. This hypothetical case demonstrates the capability to perform a coordinate term search exclusive of machine searching.

If a "hand search" is employed, the indexer is compelled to approximate search completeness; therefore, he cannot rely on one index but must utilize all three of the previously indicated indexes. The unique accessions resulting from the search are always the entry points to the aperture card file.

NARDIS INVERTED SUBJECT MATTER INDEX

DESCRIPTOR TERM							DESCRIPTOR TERM						
AGENCY ACCESSION	CLASS	LINK	ROLE	ROLE	ROLE	ROLE	AGENCY ACCESSION	CLASS	LINK	ROLE	ROLE	ROLE	ROLE
ANTIGENS AND ANTIBODIES							**ANTIGENS AND ANTIBODIES**						
DN540403	U	A	8				DN623683	U	A	9			
DN541001	U	A	8				DN623836	U	A	2			
DN541002	U	A	8				DN623917	U	A	8			
DN541104	U	A	8				DN623988	U	C	0			
DN541511	U	A	8				DN624035	U	A	8			
DN541512	U	A	8				DN624103	U	A	2			
									D	0			

Figure 8 – Subject Matter Index

NARDIS KEYWORD INVERTED EDIT

KEY WRD SEC	KEYWORD					KEY WRD SEC	KEYWORD				
	AGENCY ACCESSN	RPT SEC	GRP	RPT LVL	TOTAL		AGENCY ACCESSN	RPT SEC	GRP LVL	RPT	TOTAL
U	DENTAL OFFICERS					U	DENTAL TECHNICIANS				
	DN541304	U					DN541304	U			

Figure 9 - Key Word Index

CONCLUSION

Ostensibly, the economics of an aperture card subsystem are extraordinarily reasonable and certainly enticing. Extimates based on our present use of the aperture card subsystem indicate the following approximate costs:

1. Seven cents to microfilm a report and develop the aperture card.
2. Two cents to make a diazo copy.
3. Three cents to reproduce a hard copy.

In addition to economics, the aperture card subsystem provides a simple, straightforward approach for generating and maintaining a microfilm file. This feature is absolutely essential for a system whose data base is very dynamic. Moreover, the aperture card produced is of high quality and resolution.

There is, however, one deficiency that detracts from the subsystem. The reproduced "hard copy" is usable, but not of the best quality. Coupled with this is the fact that many customers prefer a black and white copy to a thermofax-type copy. The industry is making advances in providing this capability.

Despite the sophisticated microfilm techniques that are becoming available, it appears that the aperture card will be around for some time.

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13. ABSTRACT

This report focuses on the use of the aperture card as an adjunct to a computerized information system. System configuration, economics, environment, and functionality are the salient points considered.

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Adjunctive System						
File Maintenance						
Retrieval						
System Configuration						
Economics						
Systems Flexibility						
Document Selectivity						
Hard Copy						